

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
30 August 2001 (30.08.2001)

PCT

(10) International Publication Number
WO 01/62651 A1

(51) International Patent Classification⁷: **B65H 45/20**

(21) International Application Number: **PCT/IT01/00080**

(22) International Filing Date: 20 February 2001 (20.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
FI2000A000041 23 February 2000 (23.02.2000) IT

(71) Applicant (for all designated States except US): **FABIO PERINI S.P.A. [IT/IT]**; Via per Mugnano, I-55100 Lucca (IT).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GHILARDI, Mauro** [IT/IT]; Via di Tiglio, 108, Pieve San Paolo, I-55066 Capannori (IT). **BETTI, Giulio** [IT/IT]; Via di Piaggia, 8, Vorno, I-55060 Capannori (IT). **BENVENUTI, Angelo** [IT/IT]; Via del Chiasso, 327, I-55100 Lucca (IT). **MORELLI, Alessandro** [IT/IT]; Via del Brennero, 1896, I-55017 S. Pietro a Vico (IT).

(74) Agents: **MANNUCCI, Michele et al.**; Via della Scala, 4, I-50123 Firenze (IT).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

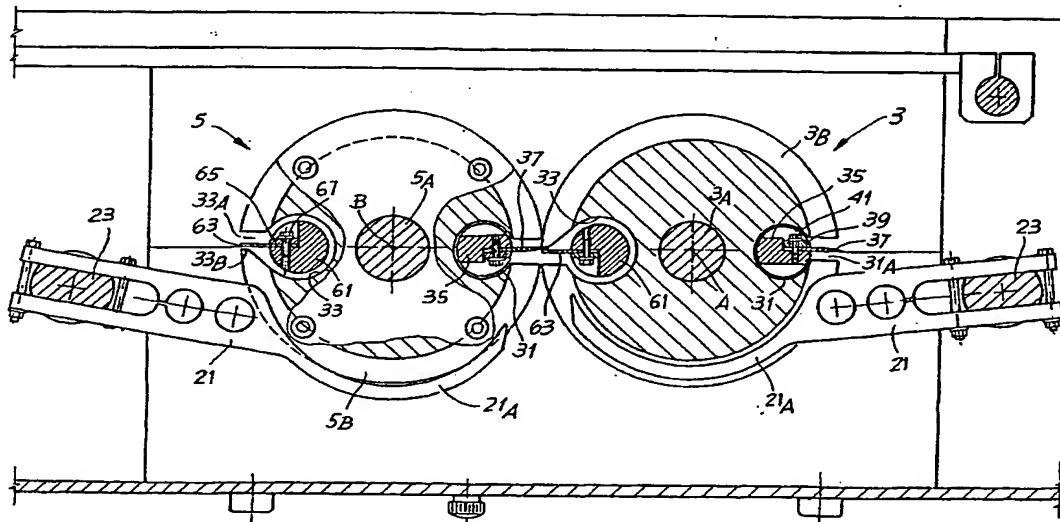
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DEVICE FOR AND METHOD OF FOLDING SHEET MATERIAL



WO 01/62651 A1

(57) Abstract: A description is given of a folding device for folding a web material (N) along transverse folding lines, comprising a pair of counter-rotating folding cylinders (3, 5) adjacent to each other with parallel axes, at least one folding blade (37) being placed in a first of said cylinders, and at least one gripping member being placed in the second of said cylinders, this gripping member comprising an oscillating shaft (61) and a stop (33B) for gripping the web material which is inserted into said gripping member by said folding blade. The gripping member also comprises an elastic strip (63) carried by said oscillating shaft (61), this strip interacting with the stop on the corresponding folding cylinder.

THIS PAGE BLANK (USPTO)

DEVICE FOR AND METHOD OF FOLDING SHEET MATERIAL

DESCRIPTION5 Technical field

The present invention relates to a folding device, usable for example in paper converting machines, for folding along transverse lines a web material, for example a sheet of paper, tissue paper or the like, which can be a continuous web, possibly already folded along a longitudinal folding line. The 10 device can also be used for folding single sheets.

Devices of this type are commonly used for the production of paper towels and handkerchiefs and the like.

The invention also relates to a machine for producing towels or other folded sheet articles, which comprises a folding device of the aforesaid type.

15 Additionally, the invention relates to a method of folding flat products.

Prior art

In many folding machines used in the paper processing industry, a web material is fed to a folding device which has a pair of counter-rotating cylinders. On each cylinder there are folding members which grip the web 20 material, which is fed continuously in a direction orthogonal to the axes of the two cylinders, and fold it along folding lines parallel to the axes of the cylinders.

These machines are used, for example, for folding a web, which can already be folded longitudinally, and which is fed to the two cylinders in a 25 zigzag configuration. The stack of material folded in the zigzag configuration is then pressed against a blade whose cutting edge is parallel to the axes of the cylinders, to divide the stack of material into two lines of towels.

A machine of this type is described, for example, in WO-A-9728076. The folding members can be configured in different ways. In general, they 30 have a folding blade on one of the two cylinders, which interacts with a gripping member on the other cylinder. The folding blade folds the web material along a folding line and inserts or forces it into the gripping member.

- 2 -

In practice, each cylinder has one or more gripping members and one or more folding blades, staggered with respect to each other such that during the synchronized rotation of the cylinders, each folding blade on one cylinder corresponds to a gripping member on the other cylinder and vice versa.

5 The configuration and movement of the folding blades and the gripping members can vary. An example of a configuration of these members is described in US-A-4,822,328. In this known device, the folding blades are mounted on corresponding floating shafts. Each gripping member comprises a rigid jaw mounted on a corresponding second shaft which is made to
10 oscillate by a cam and follower. In this system, the gripping member has no elasticity.

A different configuration of the gripping member of the known type has gripping members each of which comprises an oscillating shaft driven by a cam and follower system. On the shaft, which extends parallel to the axis of
15 the corresponding cylinder and which is housed in a seat open toward the cylindrical surface of the cylinder, there are mounted oscillating fingers, which can oscillate to a limited extent with respect to the shaft. The axis of oscillation of the fingers coincides with the axis of the shaft. Each oscillating finger is subject to the elastic action of a spiral compression spring, which is positioned
20 between the finger and a seat formed in the cylinder. Thus each finger is elastically pressed against a fixed stop to grip the folded web material which is forced or inserted into the gripping member by the folding blade. Additionally, the shaft carrying the fingers is made to oscillate by a cam and follower system.

25 This system is very precise and accurate, and has considerable advantages over the systems in which the gripping members have no elasticity. In particular, it provides a good retention of the fold even in the case of web material which has variations in thickness along its transverse extension. However, it is difficult to construct, assemble and adjust, owing to
30 the high number of parts. Moreover, the maintenance and replacement of worn or broken components are lengthy and complicated operations.

Objects and brief description of the invention

- 3 -

The object of the invention is to provide a folding device, a machine for producing articles made from folded sheets, and a folding method, which are simpler and more economical than the known devices, machines and methods, while having the same degree of accuracy.

5 A further object of the present invention is to provide a folding device which consists of a smaller number of parts, and which is easier to construct, assemble, adjust and repair.

These and other objects and advantages, which the following text will make clear to those skilled in the art, are obtained with a device in which the 10 folding member comprises an elastic strip mounted on a shaft oscillating about its own axis, parallel to the axis of the corresponding cylinder. The elastic strip interacts with a fixed stop.

This elastic strip, made from piano wire steel for example, replaces the set of oscillating fingers and the corresponding compression springs of 15 conventional systems. As will be made clear subsequently, the device made in this way is very easily assembled, and permits much faster repair operations than the known devices.

Further advantageous embodiments of the device according to the invention are indicated in the attached claims.

20 Brief description of the drawings

The invention will be more clearly understood from the description and the attached drawings which relate to an embodiment of the invention, provided by way of example and without restrictive intent. More particularly, in the drawings,

25 Fig. 1 shows a front view, in partial section, of the cylinders of the folding device;

Fig. 2 shows a section through II-II in Fig. 1;

Fig. 3 shows a section through III-III in Fig. 1;

30 Fig. 4 shows an enlarged detail of the gripping member and the folding blade;

Fig. 4A shows a detail, in a lateral view, of a portion of the elastic strip;

- 4 -

Fig. 5 shows a schematic plan view of a machine using the folding device of Figs. 1 to 4; and

Fig. 6 shows an enlarged detail of the gripping member in the prior art embodiment.

5 Detailed description of a preferred embodiment of the invention

With initial reference to Figs. 1 to 3 and 5, the general structure of the folding device and of a folded towel production machine in which it can be used are described in the first place.

Fig. 5 shows a schematic plan view of a machine for producing towels 10 of paper or other material in folded sheet form. The machine has a folding device, indicated in a general way by 1, to which a longitudinally folded continuous web material N is fed. The folding device has a pair of counter-rotating folding cylinders 3 and 5, with axes A and B parallel to each other. The folding device will be described in greater detail with reference to Figs. 1 15 to 3.

The web material N is folded into a zigzag configuration by the folding device 1, and the stack P thus produced is pressed against a blade 7 which divides the stack P into two parts M, each consisting of towels folded in four. Separator members 9, which are not an object of the present invention and 20 which are of a known type, divide the stacks of articles M into packs, each comprising a predetermined number of articles, to be sent to the packaging machine.

As shown in greater detail in Figs. 1 to 3, the two counter-rotating folding cylinders 3 and 5 are supported by shafts 3A, 5A which are moved by 25 a drive system which is not shown. Each cylinder 3, 5 is associated with a separating comb 21, oscillating about a corresponding shaft 23. The oscillatory movement of the separating combs 21 is taken from the rotary movement of the cylinders (and is therefore synchronized with the latter movement) in a known way, by means of a transmission system which is not 30 shown.

Each tooth of the combs 21 has a curved end portion housed in a corresponding annular groove of the corresponding folding cylinder 3, 5. The

- 5 -

annular grooves are indicated by 3B and 5B. The oscillatory movement of the separating combs is shown in the plan view of Fig. 2, where the comb associated with the folding cylinder 5 is in the position in which it is farthest from the axis of the corresponding cylinder, while the comb associated with 5 the cylinder 3 is in the position in which it is closest to the axis of the cylinder.

Two seats 31 and 33 which are longitudinal, in other words parallel to the axis of the cylinder, are formed in each cylinder 3, 5. A support consisting of a first oscillating shaft 35 is inserted into the seat 31 of each cylinder. A folding blade 37, commonly called a "wedge", is mounted on the support by 10 means of a fixing plate 39 and securing screws 41 (see also the enlargement in Fig. 4). The folding blade or wedge 37 has recesses 37A (Fig. 1) corresponding to the annular grooves 3B or 5B of the cylinder, so that it does not interfere with the teeth of the folding combs 21. Alternatively, the folding blade 37 can be made in a plurality of portions which are aligned and spaced 15 apart. It is also possible to make the folding blade 37 have recesses 37A while still being made in a plurality of aligned portions, for example in order to simplify assembly and/or to permit the partial replacement of the blade in case of wear or breakage. In any case, the term "folding blade" denotes a blade consisting of a single piece or a plurality of aligned portions.

20 As shown in particular in the plan view in Fig. 2 and in the enlargement in Fig. 4, the screws 41 can be accessible from the exterior, by suitable orientation of the support shaft 35, through the lateral slot 31A of the seat 31, through which the blade 37 emerges from the seat and projects beyond the lateral surface of the folding cylinder.

25 Each of the oscillating shafts 35 supporting the folding blades 37 is pressed towards a resting position by a spiral tension spring 45 placed in the lower part of the corresponding cylinder (see Fig. 3), and secured at one end to a block 47 fixed to the folding cylinder and at the opposite end to a bracket 49 locked on the shaft 35. The bracket 49 and the shaft 35 are pressed by the 30 spring 45 against a stop 51 integral with the corresponding folding cylinder 3 or 5, which determines the angular resting position of the folding blade 37. Each shaft 35 is caused to oscillate, during operation, by the interference

- 6 -

between the folding blade and the gripping member, which is described below, and which is housed in the seat 33 in the opposite cylinder (as shown for the folding blade of the cylinder 5).

In the seat 33 of each folding cylinder 3, 5 there is placed a second 5 oscillating shaft 61, which has a flat 61A. An elastic strip 63 is applied to the flat 61A and has, in the same way as the folding blade 37, recesses 63A corresponding to the annular grooves 3B or 5B of the corresponding folding cylinder (see Fig. 1 and Fig. 4A), to prevent interference with the folding combs 21 during the rotation of the cylinders. The elastic strips 63 can also be 10 made in a plurality of portions aligned and spaced apart, instead of with recesses 63A. Alternatively, they can be made in a plurality of aligned portions while still having recesses 63A, to facilitate replacement. The term "elastic strip" denotes in a general way a single strip or a strip consisting of a plurality of portions.

15 The strip 63 is fixed on the oscillating shaft 61 by means of a fixing plate 65 and securing screws 67, on the flat 61A. The securing screws 67 engage in laterally open slots 63B, shown in particular in the enlarged detail in Fig. 4A, which shows a lateral view of a portion of the strip 63. The slots 63B allow the strip 63 to be extracted from its seat when the screws 67 have been 20 slackened, without the necessity of completely removing the screws. A similar mounting system, with open slots, is provided for the folding blade or wedge 37.

25 The strip 63 extends radially approximately up to the lateral cylindrical surface of the corresponding folding cylinder 3 or 5, without projecting beyond this, and extends into a longitudinal aperture or slit 33A of the seat 33. As shown, in particular, in Fig. 2 and in the enlargement in Fig. 4, by suitable angular orientation of the oscillating shaft 61 the securing screws 67 are made accessible from the exterior through the aperture 33A and allow the elastic strips 63 to be mounted, removed and repaired without the need to dismantle 30 the cylinder and the oscillating shaft 61.

Each elastic strip interacts with a stop 33B formed by an edge of the longitudinal aperture 33A of the seat 33, so that the web material N inserted

by the folding blade 37 is gripped between the elastic strip 63 and the fixed stop 33B, as shown in particular in the enlargement in Fig. 4. Each elastic strip 63 and the corresponding fixed stop 33B form the gripping member for the web material.

5 The oscillatory movement of the shaft 61 is produced, in the illustrated example, by a grooved cam 73 interacting with a roller 69 carried by an arm 71 (see Fig. 3) integral with the shaft 61. Alternatively, it is possible to use a disc cam with a follower pressed elastically, in the way used to obtain the movement of the oscillating shaft 35.

10 The operation of the device described above is essentially similar in its general characteristics to that of conventional devices: the flat material is fed between the two counter-rotating folding cylinders 3, 5 and is cyclically folded by one of the folding blades 37 which forces or inserts the web material between the elastic strip 63 and the stop 33B. The elastic strip 63 presses the 15 folded area of the web material against the fixed stop 33B. The material is gripped until the folding line reaches a suitable angular position, where the gripping member releases the web material which is separated from the corresponding combs 21 and pushed toward the cutting blade 7.

20 The elastic strip 63 flexes when it is pressed against the corresponding stop 33B, and is made, for example, from piano wire steel, so that it has the requisite elasticity.

25 However, the gripping member has a much simpler structure than that found in conventional devices, as demonstrated by a comparison of Figs. 2 and 4 with Fig. 6, which shows in detail the gripping member according to the prior art. In the conventional device of Fig. 6, fingers 101 are pivoted within the oscillating shaft, which is again indicated by 61, and are free to move through a few degrees with respect to the shaft. Each finger is pressed elastically against the stop, again indicated by 33B, by a corresponding spiral compression spring 103 held in a seat 105 by a headless screw 107. The end 30 of the compression spring 103 projecting from the seat 105 interacts with the corresponding finger 101 and is held by a pin 109. The elasticity of the folding member is provided in this case by the compression springs 103. It is clear

- 8 -

that the mounting, removal and replacement of the fingers 101 of the device of Fig. 6 is very complicated. By contrast, the elastic strip 63 of the present invention imparts the same elastic action to the gripping member with a much simpler and more economical structure.

5 It is to be understood that the drawing shows only a possible embodiment of the invention, which can be varied in its forms and arrangements without departure from the basic concept of the invention. The presence of any reference numbers in the attached claims has the sole purpose of facilitating the reading of the claims with reference to the
10 description and the drawings, and does not in any way limit the scope of protection.

CLAIMS

1. A folding device for folding a web material along transverse folding lines, comprising a pair of counter-rotating folding cylinders adjacent to each other with parallel axes, at least one folding blade being placed in a first of said cylinders, and at least one gripping member being placed in the second of said cylinders, said gripping member comprising an oscillating shaft and a stop for gripping the web material which is inserted into said gripping member by said folding blade, characterized in that said gripping member comprises at least one elastic strip carried by said oscillating shaft, said strip interacting with said stop, the oscillation of said shaft causing the web material to be gripped and released, and said elastic strip being flexed by pressure against said stop during the gripping.

2. The device as claimed in claim 1, characterized in that said oscillating shaft is housed in a seat which is formed in the corresponding cylinder and which is open outwardly along a slit parallel to the axis of the cylinder, said slit forming said stop.

3. The device as claimed in claim 1 or 2, characterized in that said oscillating shaft has a longitudinal flat, on which said elastic strip is fixed.

4. The device as claimed in claims 2 and 3, characterized in that said elastic strip is fixed on said oscillating shaft by screw means accessible from the exterior through said slit for mounting and removing said elastic strip.

5. The device as claimed in one or more of the preceding claims, characterized in that at least one gripping member and at least one folding blade are positioned on each of said cylinders in angularly staggered positions, each folding blade on one cylinder being in phase with a corresponding gripping member on the other cylinder.

6. The device as claimed in claim 5, characterized in that each cylinder is associated with a separating comb for separating the folded web material from the corresponding cylinder, and in that said elastic strip and said folding blade have recesses to permit the passage of said separating combs.

7. A machine for producing folded articles from a web material, comprising:

- 10 -

- feeding means for feeding the continuous web material;
- a folding device for folding the continuous web material in zigzag configuration;
- a cutting member for cutting the folded web material in zigzag configuration,

5

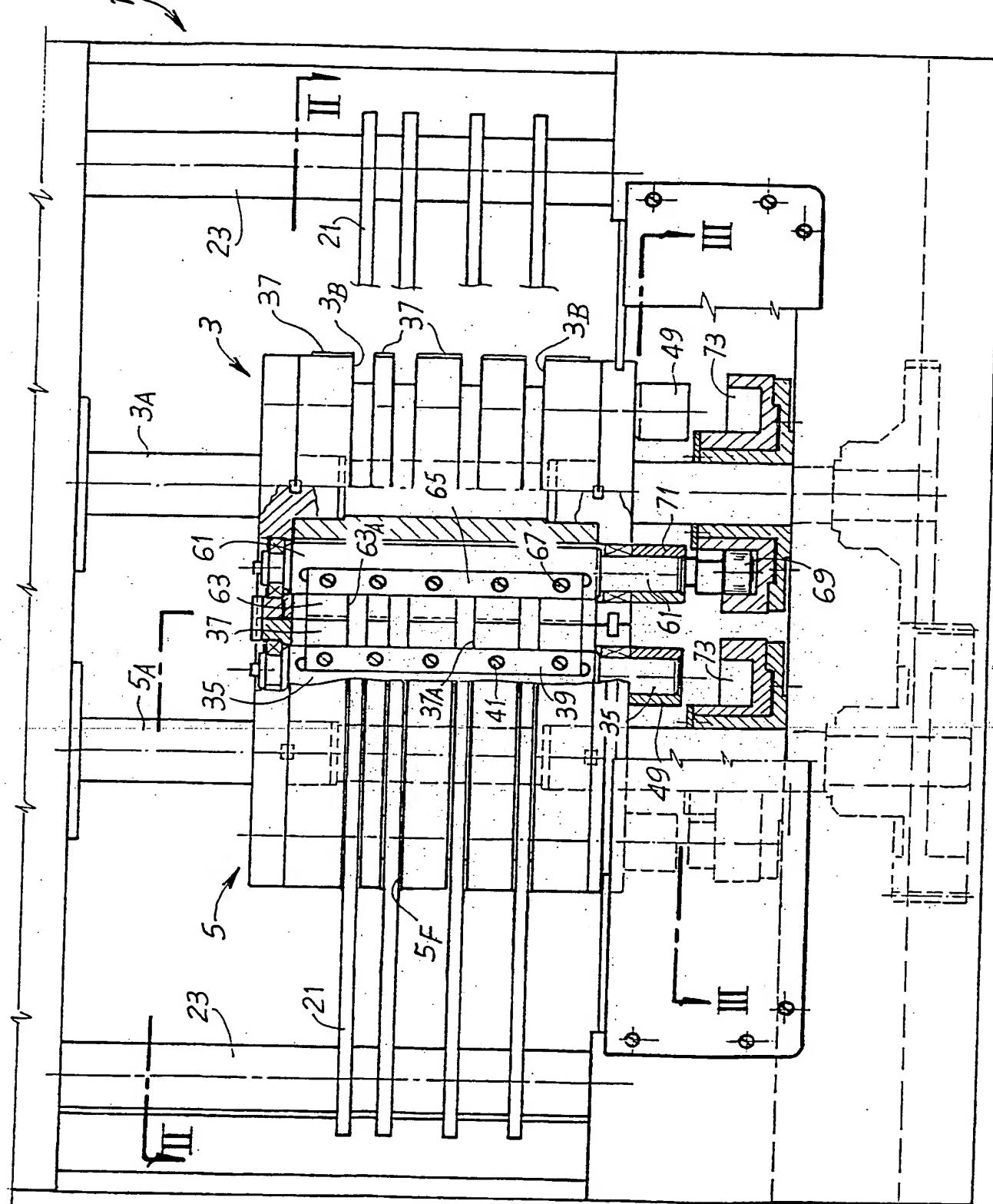
characterized in that said folding device is made according to one or more of claims 1 to 6.

8. Method for folding a web material with a folding device comprising a first folding cylinder and a second folding cylinder, on each of which is positioned at least one folding blade interacting with a corresponding gripping member on the other cylinder, wherein the web material is inserted by said folding blade into said gripping member and subsequently released by said gripping member, characterized in that said gripping member is made with an elastic strip interacting with a stop on the corresponding cylinder, and in that said elastic strip is flexed against said fixed stop to retain the web material with said gripping member.

10

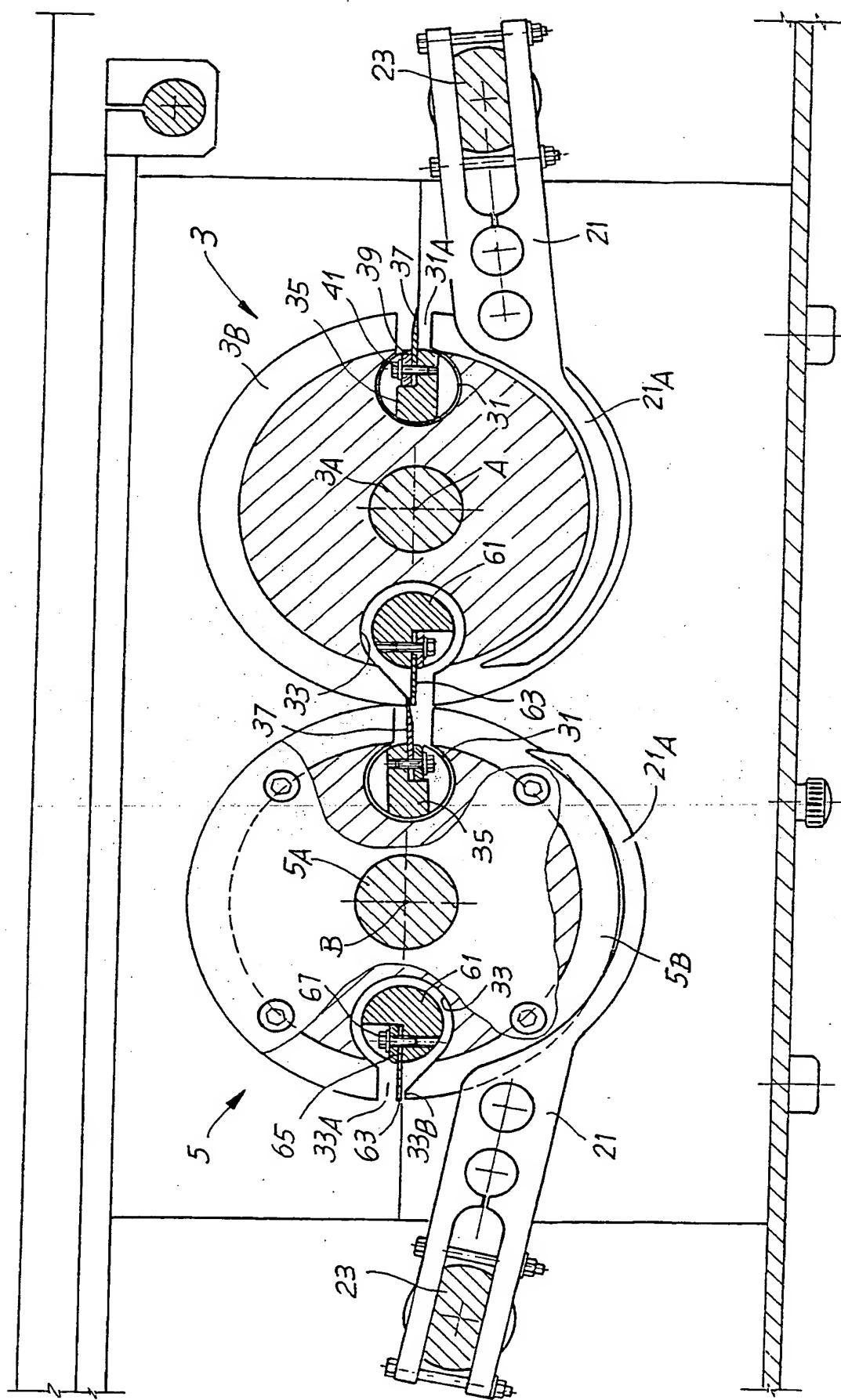
15

Fig.1



THIS PAGE BLANK (USPTO)

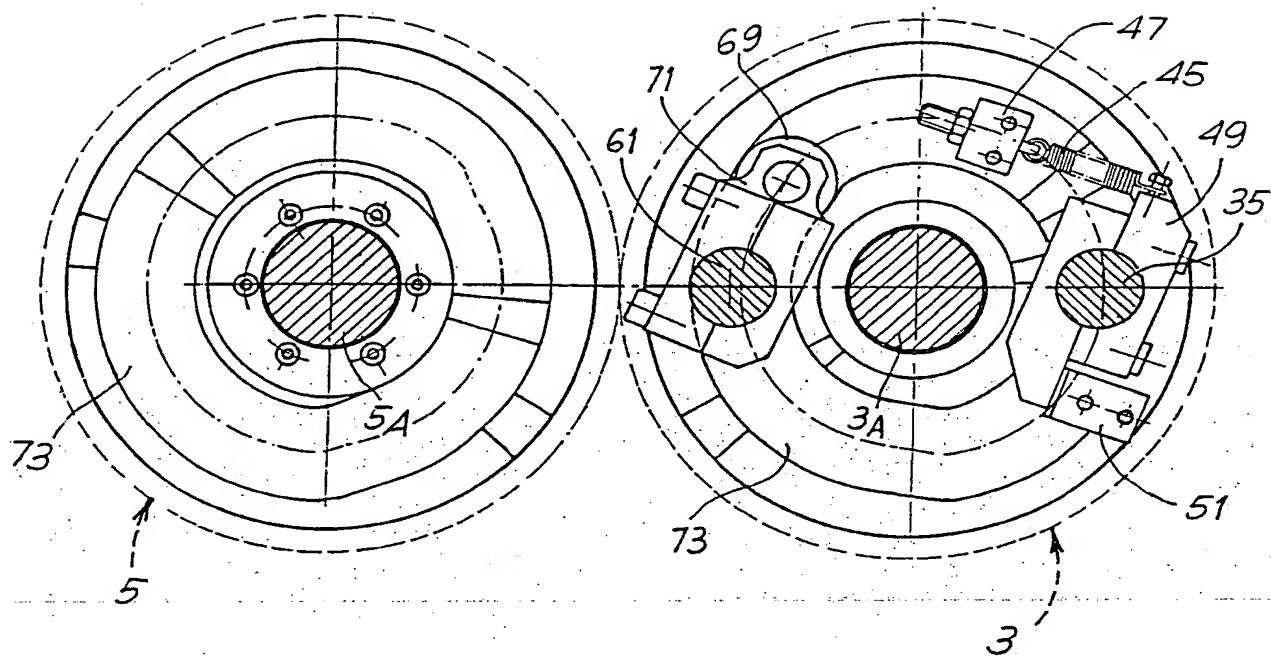
Fig. 2



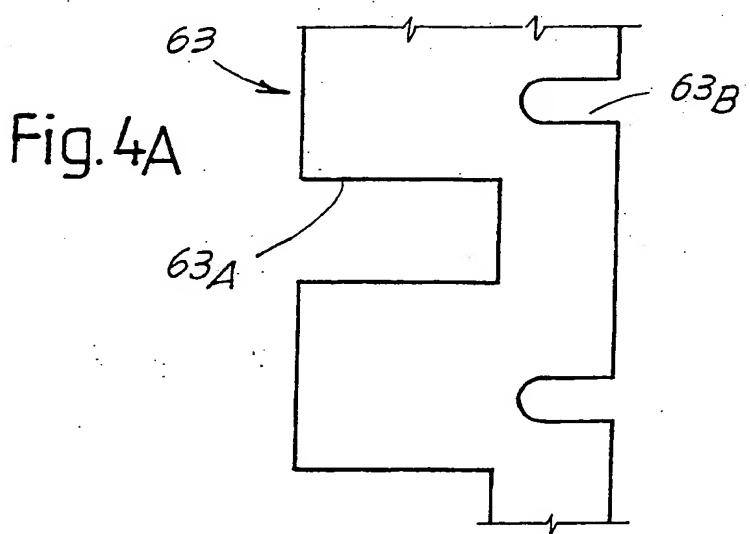
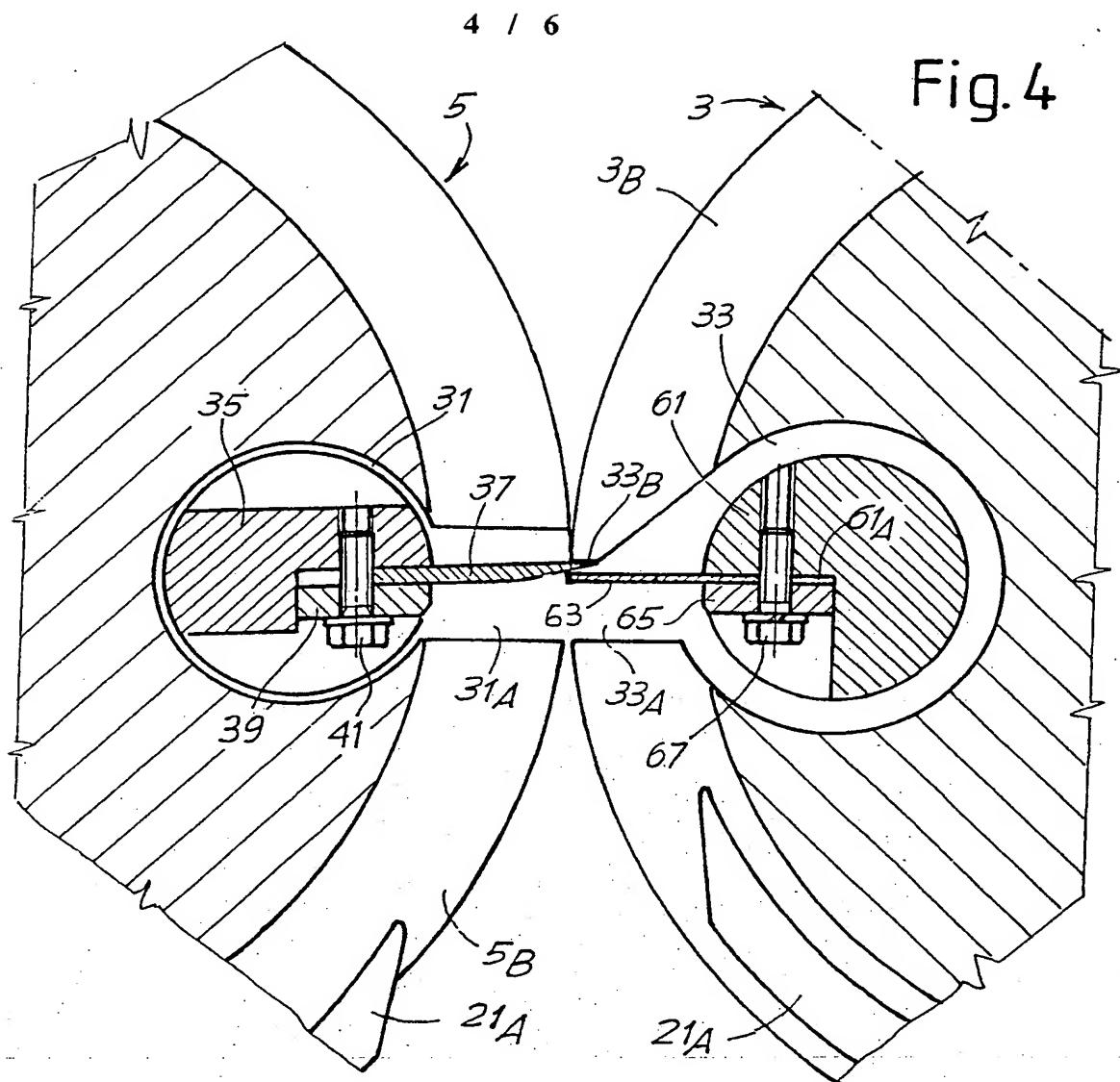
THIS PAGE BLANK (USPTO)

3 / 6

Fig. 3

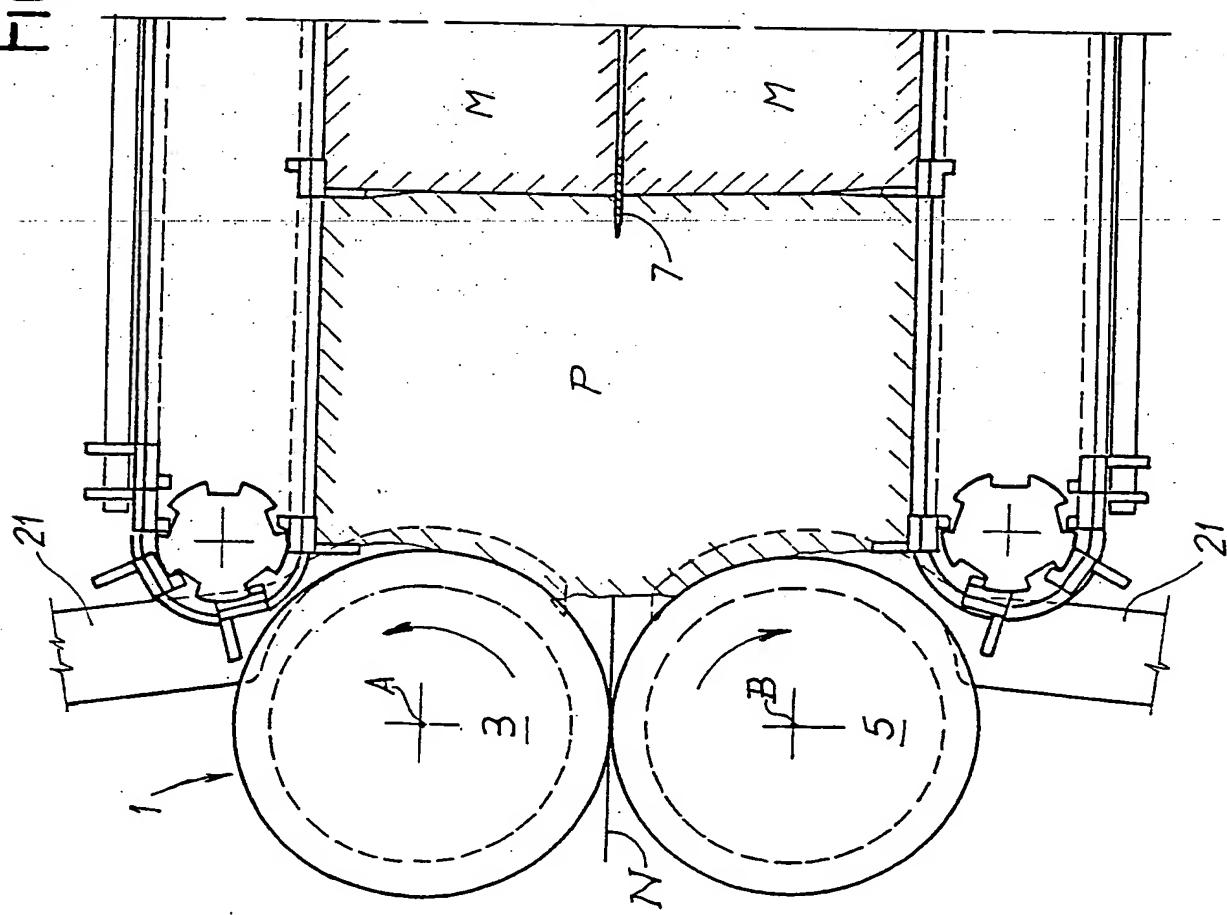
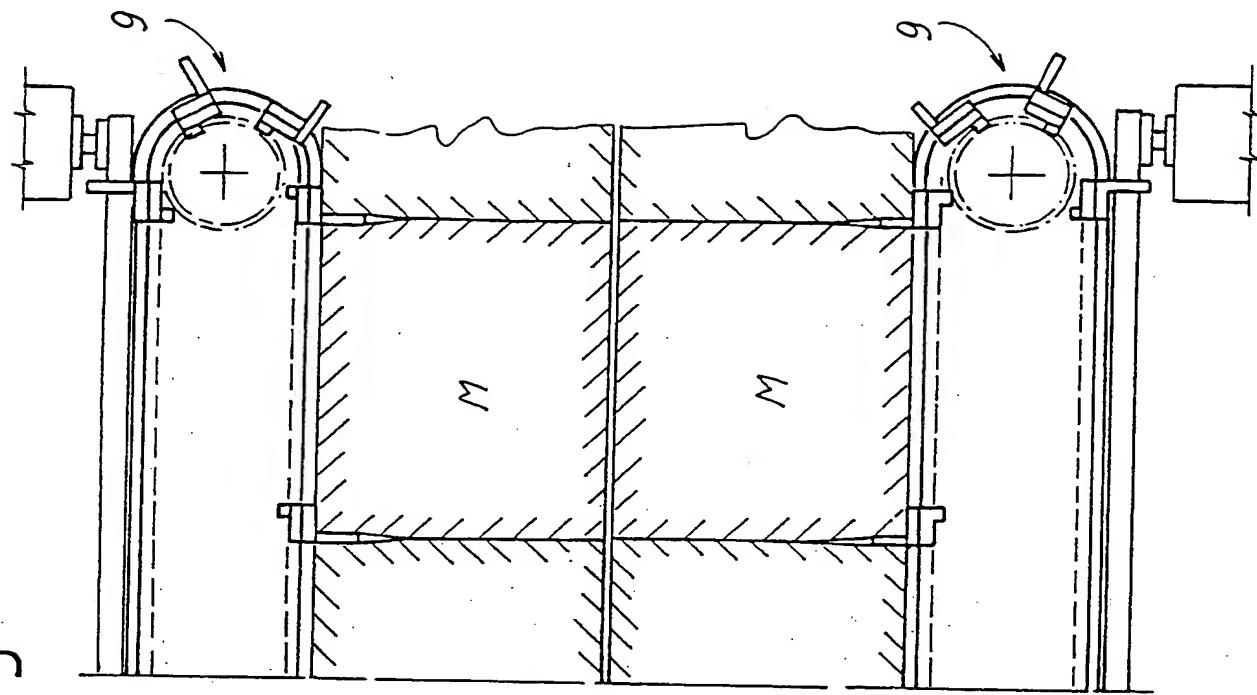


THIS PAGE BLANK (USPTO)



THIS PAGE BLANK (USPTO)

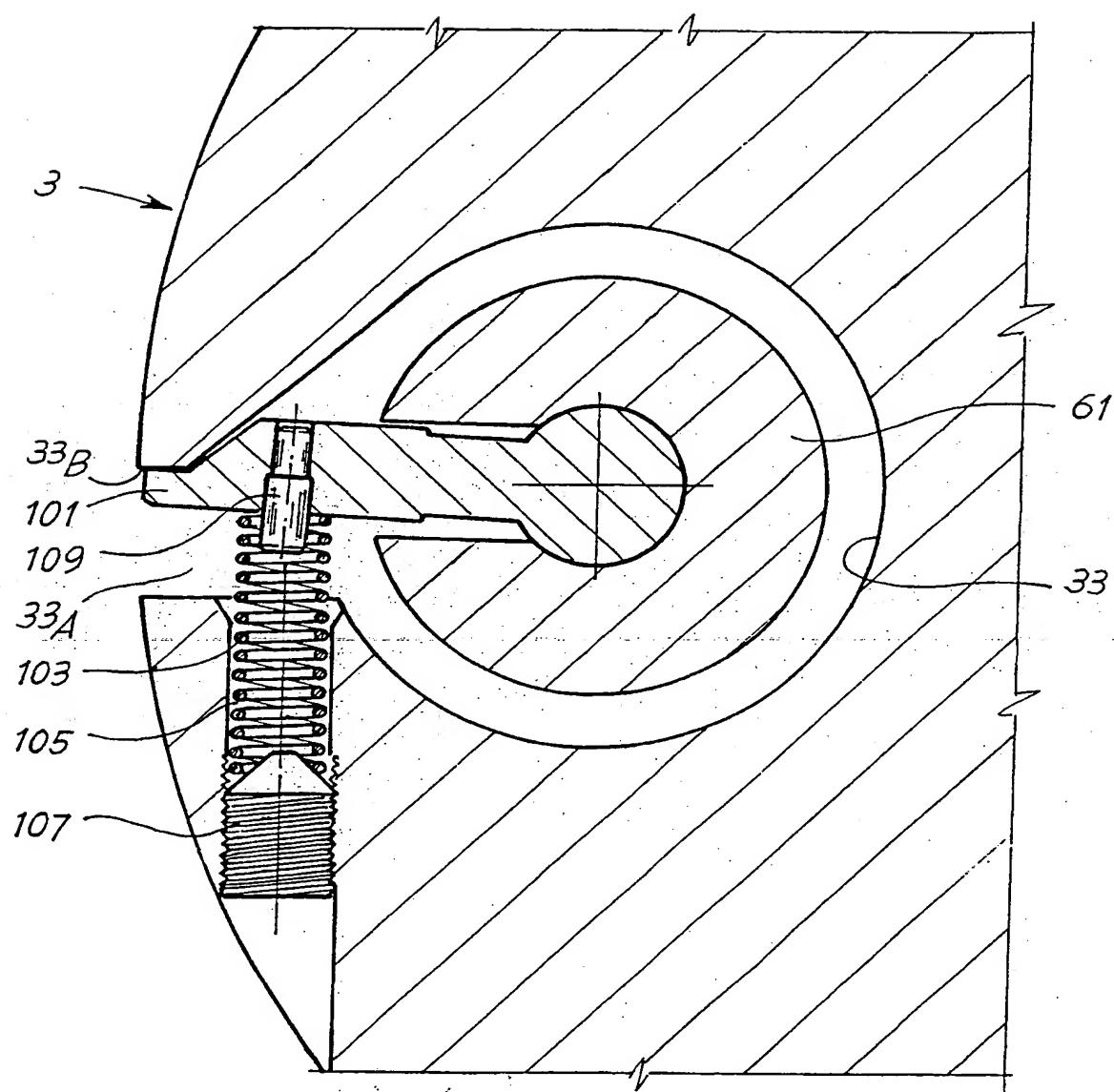
Fig. 5



THIS PAGE BLANK (USPTO)

6 / 6

Fig. 6

*State of the art*

THIS PAGE BLANK (USPTO)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 01/00080

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 B65H45/20		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 B65H		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 195 882 A (E. D. NYSTRAND) 20 July 1965 (1965-07-20) column 1, line 68 -column 2, line 41 column 4, line 12 - line 60; figures ----	1,3,5,8
Y	US 3 229 974 A (C. T. BANKS) 18 January 1966 (1966-01-18) column 4, line 14 - line 19 column 5, line 26 - line 50; figures 1-3 ----	2,4,6,7
Y	WO 97 28076 A (FABIO PERINI S.P.A.) 7 August 1997 (1997-08-07) cited in the application page 7, line 11 - line 36; figure 1 ----	2,4
A	-----	1,5-8
Y	-----	6,7
A	-----	1,5,8
	-----	-/-
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.		<input checked="" type="checkbox"/> Patent family members are listed in annex.
<p>* Special categories of cited documents:</p> <p>*A* document defining the general state of the art which is not considered to be of particular relevance</p> <p>*E* earlier document but published on or after the international filing date</p> <p>*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>*O* document referring to an oral disclosure, use, exhibition or other means</p> <p>*P* document published prior to the international filing date but later than the priority date claimed</p>		
<p>*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>*&* document member of the same patent family</p>		
Date of the actual completion of the international search	Date of mailing of the international search report	
11 June 2001	22/06/2001	
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Fuchs, H	

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 01/00080

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 44 46 753 A (OFFICINE MECCANICHE GIOVANNI CERUTTI S.P.A.) 21 December 1995 (1995-12-21) column 4, line 35 - line 48; figures 4,5 ---	1,2,4,7, 8
A	US 3 689 061 A (NYSTRAND) 5 September 1972 (1972-09-05) column 3, line 57 -column 4, line 9; figure 2 ---	1,2,4,7, 8
A	US 4 822 328 A (BERTOLINI ET AL.) 18 April 1989 (1989-04-18) cited in the application figures -----	1,2,5,7, 8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IT 01/00080

Patent document cited in search report	Publication date	Patent family member(s)			Publication date
US 3195882	A 20-07-1965	NONE			
US 3229974	A 18-01-1966	NONE			
WO 9728076	A 07-08-1997	IT FI960008 A			30-07-1997
		AT 193270 T			15-06-2000
		AU 1617097 A			22-08-1997
		BR 9707478 A			06-04-1999
		CA 2244832 A			07-08-1997
		CN 1210500 A			10-03-1999
		DE 69702118 D			29-06-2000
		DE 69702118 T			01-02-2001
		EP 0879200 A			25-11-1998
		ES 2146078 T			16-07-2000
		GR 3033540 T			29-09-2000
		JP 2000503953 T			04-04-2000
		US 6120240 A			19-09-2000
DE 4446753	A 21-12-1995	IT 1270245 B			29-04-1997
US 3689061	A 05-09-1972	AT 312409 B			15-11-1973
		BE 767401 A			18-10-1971
		CA 929180 A			26-06-1973
		DE 2120903 A			13-01-1972
		FR 2097789 A			03-03-1972
		GB 1290829 A			27-09-1972
		JP 51034327 B			25-09-1976
		SE 366967 B			13-05-1974
US 4822328	A 18-04-1989	AT 87883 T			15-04-1993
		AU 2730688 A			22-06-1989
		BR 8806791 A			29-08-1989
		CA 1307802 A			22-09-1992
		DE 3880115 A			13-05-1993
		DE 3880115 T			15-07-1993
		EP 0322186 A			28-06-1989
		JP 1209274 A			23-08-1989
		MX 165670 B			27-11-1992
		US 4951569 A			28-08-1990



THIS PAGE BLANK (USPTO)